Assignment 3

The due date for submitting this assignment has passed. As per our records you have not submitted this assignment.  

Due on 2018-09-05, 23:59 IST.

1) Given an energy band diagram, how can one find the electric field?  
   - It is proportional to $E_C$. 
   - It is proportional to minus $E_C$. 
   - It is proportional to the slope of $E_C$. 
   - It is proportional to the minus of the slope of $E_C$. 

   **No, the answer is incorrect.**

   **Score: 0**

   **Accepted Answers:**  
   - It is proportional to the slope of $E_C$.  

2) Consider an n-type semiconductor at 0K temperature. Where do you expect the Fermi level to be?  
   - Inside the valence band.  
   - Inside the conduction band.  
   - Near the middle of the band-gap.  
   - Between the donor level and the conduction band. 

   **No, the answer is incorrect.**

   **Score: 0**

   **Accepted Answers:**  
   - Between the donor level and the conduction band.
4) As temperature increases from 0K to high temperature, the carrier concentration goes through three regions. In what order does the transition occur?

- Intrinsic, extrinsic, freezeout  
- Freezeout, extrinsic, intrinsic  
- Freezeout, intrinsic, extrinsic  
- Intrinsic, freezeout, extrinsic

No, the answer is incorrect.  
Score: 0  
Accepted Answers: 
Freezeout, extrinsic, intrinsic

5) An intrinsic germanium wafer is doped with a shallow acceptor density of $3n_i$, where $n_i$ is the intrinsic carrier concentration. At temperature $T$, all the acceptors are ionized. Calculate the hole density at temperature $T$.

- $2n_i$  
- $3n_i/2$  
- $n_i/2$  
- $n_i$

No, the answer is incorrect.  
Score: 0  
Accepted Answers: 
$2n_i$

6) Under which condition the position of the Fermi level in an intrinsic bulk semiconductor lies exactly at the middle of the band-gap at a non-zero temperature $T$?

- When effective mass of electrons = effective mass of holes.  
- When mobility of electrons > mobility of holes  
- When the energy band-gap > $2kT$  
- Fermi level of an intrinsic semiconductor will always lie at the middle of the band-gap.

No, the answer is incorrect.  
Score: 0  
Accepted Answers: 
When effective mass of electrons = effective mass of holes.

7) Assume two semiconductors A and B have the same effective density of states both at the conduction band edge ($N_C$) and the valence band edge ($N_V$). The intrinsic carrier concentration of A
and B at 300K are respectively $1.5 \times 10^3 \text{ cm}^{-3}$ and $3.2 \times 10^3 \text{ cm}^{-3}$. What is the band-gap of semiconductor B if the semiconductor A has a band-gap of $1.12 \text{ eV}$?

- 1.12 eV
- 1.44 eV
- 1.92 eV
- 0.74 eV

No, the answer is incorrect.
Score: 0
Accepted Answers:
1.44 eV

8) The probability of a state being filled by an electron at energy $E_C - kT$ is equal to the probability of a state being filled by a hole at energy $E_V - 3kT$. Where is the Fermi level located?

- $3kT$ above the valence band edge.
- $3kT$ below the valence band edge.
- $2kT$ above the conduction band edge.
- $2kT$ below the conduction band edge.

No, the answer is incorrect.
Score: 0
Accepted Answers:
$2kT$ below the conduction band edge.

9) A silicon wafer is doped with $10^{16} \text{ cm}^{-3}$ arsenic atoms. The donor level $E_d$ is located at $54 \text{ meV}$ below $E_C$. What percentage of the donor atoms are ionized at $T = 77 \text{ K}$? [Assume, $N_C(T = 77\text{K}) = 4.2 \times 10^{18} \text{ cm}^{-3}$ and the degeneracy factor of donor level, $g_D = 2$]

- 100 %
- 65.5 %
- 22.3 %
- 10.9 %

No, the answer is incorrect.
Score: 0
Accepted Answers:
22.3 %

10) For a certain semiconductor, the densities of states in the conduction and valence bands are $g_C(E) = A(E - E_C)$ and $g_V(E) = B(E_V - E)$ respectively, where $A$ and $B$ are two non-zero constants. Assume Boltzmann distribution for both types of carrier. Consider the reference potential energy level at the valence band edge, i.e. $E_V = 0$, $E_C$ is the energy at the conduction band edge. If $A = 2B$, compute the intrinsic Fermi energy at 300K.

- $E_C/2 - 9 \text{ meV}$
- $E_C/2 + 9 \text{ meV}$
- $E_C - 26 \text{ meV}$
The expression $E_C + 26 \text{ meV}$ is incorrect. 

Score: 0

Accepted Answers:

$E_C/2 - 9 \text{ meV}$